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Permalink

<https://escholarship.org/uc/item/4v9543xz>

Journal

STROKE, 38(2)

ISSN

0039-2499

Authors

Cramer, Steven C
Der-Yeghiaian, Lucy
See, Jill
et al.

Publication Date

2007

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Peer reviewed

Robot-Based Hand Motor Therapy After Stroke

Steven C Cramer, Lucy Der-Yeghian, Jill See, Vu Le, Craig D Takahashi, Univ of California, Irvine, Irvine, CA

BACKGROUND: Intense active repetitive movement practice can reduce motor deficits after stroke. Robots have unique potential in this regard, for example, providing therapy for long time periods; content can be programmed, consistent, and measured in real time; patient responses are recorded; and all can be remote (telerehabilitation), holding promise for underserved populations and improved compliance. Hand function has received limited attention in robotic therapy approaches. The current study hypothesized that a hand-wrist robot would improve motor function in chronic stroke in a dose-dependent manner. **METHODS:** A Hand-Wrist Assisting Robotic Device ('HOWARD') was constructed. Eleven subjects with chronic stroke producing moderate right arm/hand weakness received 15 two-hour sessions over 3 weeks. Content of therapy emphasized movement speed, force, precision, timing, and repetition, and included virtual reality/games. Each hand movement was initiated by the subject, and if necessary, completed by the robot. In 5 subjects, this form of robotic assistance was available at all of the sessions. In 6 subjects, this form of robotic assistance was available at only the second half of the sessions, while in the first half of sessions, the subject initiated movement but no robotic assistance was available to complete the hand movement. **RESULTS:** Significant within subject gains were found from baseline to end of treatment for both primary endpoints: Action Research Arm Test (34 +/- 19, to 38 +/- 19, mean +/- SD, $p < 0.0005$, 2-tailed paired t-test) and Box-and-Blocks test (18 +/- 16, to 22 +/- 18, $p < 0.005$). Secondary endpoints such as arm motor Fugl-Meyer score and active ROM also showed significant gains. Subjects with robotic assistance in all sessions showed significantly greater gains than those with robotic assistance in half of sessions for some endpoints. **CONCLUSIONS:** Therapy based on a robotic device shows dose-dependent improvements in hand motor function after chronic stroke.